

# AN ASSESSMENT OF PLANTAR ARCH INDEXES AND PREVALENCE OF FLAT FOOT (*PESPLANUS*), IN RELATION TO OCCUPATIONS IN IKWO L.G.A OF EBONYI STATE, NIGERIA

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## ABSTRACT

*The presence of the arches of the foot, especially the medial longitudinal arch shapes the foot to aid weight absorption and transmission of body weight during stance and dynamic positions. Absence of the medial longitudinal arch results to flat foot and this could be physiological (in children) or acquired. The present study, therefore, assessed the Planter Arch Indexes (PAI) and prevalence of flat foot in relation to occupation in Ikwo L. G. A of Ebonyi State, Nigeria. The study was carried out using a total sample size of 241 adult indigenes of Ikwo L. G. A. of Ebonyi state comprised of farmers (68 males and 72 females) and civil servants (male 56, female 45). The data were obtained through direct foot scans using HP photo scanner with scanning software. The data were analyzed using graph pad to obtain the mean, standard deviation, and paired t-test at 0.05 significant level. The result of the study showed among others, the mean values of normal male and female planter arch indexes of civil servants and farmers. The prevalence of flat foot revealed farmers 2.9% and civil servants, 3.3%, while the prevalence of right flat foot was 4.15% and left foot 2.5%. Male and female flat feet were also recorded as 3.7% and 2.5% respectively. The paired t test of the planter arch index and flat foot revealed not statistically significant both in gender and occupation, however, there was a statistical difference in female civil servant and farmers of 0.0022 at  $p < 0.05$  significant levels. Based on the findings, the recommendations were forwarded to the clinicians, (specifically orthopedic surgeons), foot wear industries, students and academics for accessibility of information and further studies. In view of the results, the study concluded that there are no significant statistical differences in the variation of planter arch indexes and flat foot of the male and female civil servants and farmers in Ikwo L.G.A of Ebonyi State, Nigeria.*

**KEYWORDS:** Civil Servants, Farmers, Flat Foot & Planter Arch Index

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## INTRODUCTION

The feet are seen more distally in the lower limb, and are equally responsible for weight reception and generation of torque required for propulsion during dynamic activities (Shozo, 1984). The anatomical disposition of the foot gives it a concave shape, which is as a result of the presence of the planter arches. The general shape of the articulated tarsal and metatarsal bones of the foot is that of half dome, concave inferiorly. Because the foot is composed of numerous bones connected by ligaments, it has considerable flexibility that allows it to deform with

each ground contact, thereby absorbing much of the shock. However, the tarsal and metatarsal bones are arranged in longitudinal and transverse arches that add to the weight bearing capabilities and resiliency of the foot (Moore, 2014). The medial longitudinal arch therefore, is formed by bones, ligaments, and tendons and its configuration depend on age and genetic factors (Kanatli *et al.*, 2001).

Any alteration in the anatomical disposition of the foot leads to a deformed foot such as flat foot or *Pesplanus* (Maheshwari, 1997; Natarajan, 1994). In addition, the normal concavity due to the medial longitudinal arch is absent which leads to the medial side of the foot bugles as a medial convexity, especially during weight bearing (Krupaet al., 2015). As foot arches begin to develop with increased rate of activities in the infants, it would be pertinent to investigate the impacts of hyper activity such as increased/prolonged weight bearing during development of the arches.

In Ebonyi state, children of 10years to adolescents engage fully in strenuous farming activities. Thus, as farmlands are made of rough terrain and undulating topography, farmers are faced with the challenge of walking through these rough areas, thereby putting pressure on the foot arches which are being formed. This could lead to rupture of the ligaments and tendons (posterior tibia tendon), which has been reported as part of the causes of acquired flat foot ((Pranati *et al.*, 2017; McCormack *et al.*, 1998; Malicky *et al.*, 2005). On the contrary, Pranati *et al.* (2017) posited that the varying terrain of the lands may facilitate the formation of the arches and even brings about higher arches as stated by.

Thus, there could be great variations in the planter arch indexes among farmers and civil servants. This is what the present study focused on; determining the impact of occupation on the development of the foot arches, and as well determined the variations in the planter arch indexes among farmers and civil servants.

Many studies have been carried in foreign countries on the assessment of plantar arch indexes and prevalence of flat foot in children, adolescents and adults, using different materials. However, in Nigeria, specifically in (Ikwo) Ebonyi state, there seems to have no well documented data to support the above view-points. Also, correlation of the planter arch indexes and prevalence of flat foot in relation to occupation seem to have been under-reported by studies both locally and in foreign countries. It is against this backdrop that the researcher sought to assess the plantar arch indexes and prevalence of flat foot in relation to occupation such as farming and civil service in Ikwo L. G. A of Ebonyi state, Nigeria.

## MATERIALS AND METHODS

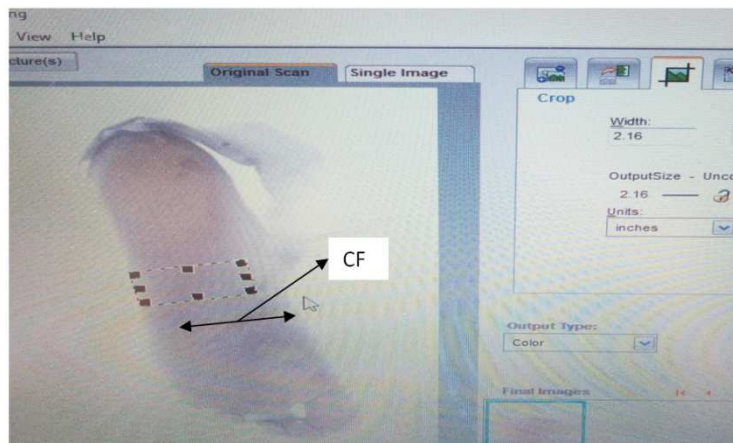
This study was carried out on a total of 241 adult indigenes (of age 18 years and above) in Ikwo L. G. A. of Ebonyi state. The subjects were grouped into two categories of occupations which are of farmers (68 males and 72 females) and civil servants (56 males, 45 females). Footprints of all the subjects were taken using a photo scanner (HP Scanjet 300 Flatbed Photo Scanner). Foot was cleaned from dirt before taking prints, in order to achieve this, a little pressure was put to press the plantar on the scanner for adequate contact between the plantar foot and the scanner to have a clear image of the print, with the aid of the software, the dimensions (width of the central foot and the rear foot) of the images captured were obtained by cropping out the interested areas and the prints were taken thrice.

For calculating the plantar arch index, a tangential line is drawn connecting the medial forefoot edge and heel region. The mean point of this line is calculated. From this point, a perpendicular line is drawn crossing the footprint. The same procedure is repeated for heel tangency point. The width of the central region of the foot print is considered as A and the width of the heel region is considered as B. The Plantar Arch Index (PAI) is obtained by dividing the A value by B value ( $PAI = A/B$ ). If PAI is greater than 1.15, then it is considered as flat foot Hernandez et al. (2007).

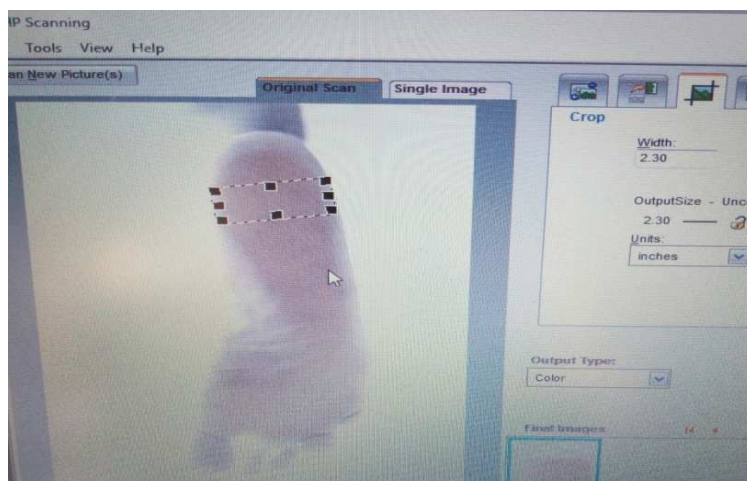
CF – width of the central region of the foot scan (in cm)

RF – width of heel region of the foot scan (in cm).

The general method of data collection is described with the images below:



**Figure 1: Showing the Diagram of the Position of the Centre of the Foot**



**Figure 2: Diagram Showing the Measurement of the Rear Foot (RF)**

## STATISTICAL ANALYSIS

In line with the nature of the research design, the study adopted descriptive statistical methods of measures of central tendency such as the arithmetic mean, mean, standard error and percentage frequency. Inferential statistics of paired t test were adopted for the purpose determining the statistical differences. All these were done with the aid of graph pad analytical software.

## RESULTS

Table 1 reveals the descriptive result of male and female civil servants with left and right normal feet. The male was as follows; width of central foot (right=  $4.677 \pm 0.61$ cm, left =  $4.759 \pm 0.672$ cm), width of rear foot (right=  $5.569 \pm 0.62$ , left =  $5.576 \pm 0.529$ ) and planter arch index as (right,  $0.846 \pm 0.11$ cm, left,  $0.857 \pm 0.123$ ) and the female presented

thus; The right and left feet are  $4.707 \pm 0.74\text{cm}$  and  $4.870 \pm 0.730\text{cm}$  respectively; and the right and left rear feet measure  $5.598 \pm 0.67\text{cm}$  and  $5.606 \pm 0.654\text{cm}$  respectively. The planter arch index of the right and left feet are recorded as  $0.839 \pm 0.91\text{cm}$  and  $0.845 \pm 0.144\text{cm}$  respectively

**Table 1: Descriptive Result of Male and Female Civil Servants with Normal Feet**

Variables	Right Feet						Left Feet					
	Male			Female			Male			Female		
	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min
CF	$4.677 \pm 0.61$	6.050	3.760	$4.707 \pm 0.74$	6.040	3.120	$4.759 \pm 0.672$	6.550	3.400	$4.870 \pm 0.730$	6.280	3.510
RF	$5.569 \pm 0.62$	6.830	4.050	$5.598 \pm 0.67$	6.870	3.980	$5.576 \pm 0.529$	6.650	4.430	$5.606 \pm 0.654$	6.880	4.290
PAI	$0.846 \pm 0.11$	1.140	0.600	$0.839 \pm 0.91$	1.030	0.570	$0.857 \pm 0.123$	1.210	0.530	$0.845 \pm 0.144$	1.150	0.280

CF - width of central foot, RF - width of rear foot, and PAI - planter arch index

Table 2 shows the descriptive result of male and female farmers with left and right normal feet. The male revealed as follows; width of central foot (right=  $4.486 \pm 0.60\text{cm}$ , left has  $4.622 \pm 0.596\text{cm}$ ), width of rear foot (right =  $5.382 \pm 0.59\text{cm}$ , left=  $5.512 \pm 0.590\text{cm}$ ) and planter arch index as(right,  $0.836 \pm 0.86\text{cm}$ , left,  $0.844 \pm 0.079\text{cm}$ ) and the female showed, width of the central foot recorded  $4.316 \pm 0.92\text{cm}$ ;; width of rear foot as  $5.401 \pm 0.72\text{cm}$ , and the planter arch index recorded  $0.799 \pm 0.14\text{cm}$ .On the left, width of central foot =  $4.513 \pm 0.772\text{cm}$ , with a range of 6.550-3.300; width of rear foot =  $5.404 \pm 0.528\text{cm}$  and the planter arch index recorded  $0.835 \pm 0.119\text{cm}$ .

**Table 2: Descriptive Result of Male and Female Farmers with Normal Feet**

Variables	Right Feet						Left Feet					
	Male			Female			Male			Female		
	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min
CF	$4.486 \pm 0.60$	5.800	3.400	$4.316 \pm 0.92$	6.530	2.100	$4.622 \pm 0.596$	5.960	3.680	$4.513 \pm 0.772$	6.550	3.300
RF	$5.382 \pm 0.59$	6.780	4.140	$5.401 \pm 0.72$	6.910	2.870	$5.512 \pm 0.590$	6.730	4.200	$5.404 \pm 0.528$	6.280	3.910
PAI	$0.836 \pm 0.86$	1.150	0.600	$0.799 \pm 0.14$	1.310	0.520	$0.844 \pm 0.079$	1.150	0.730	$0.835 \pm 0.119$	1.110	0.610

Table 3 reveals the descriptive result of male and female civil servants with flat foot. The male was presented as follows; width of central foot (right,  $6.303 \pm 0.37\text{cm}$ , left was  $6.740 \pm 0.724\text{cm}$ ), width of rear foot (right =  $4.690 \pm 0.59\text{cm}$ , left =  $5.220 \pm 0.223\text{cm}$ ) and planter arch index as (right,  $1.360 \pm 0.23$  and left,  $1.290 \pm 0.122\text{cm}$ ) and female was presented as follows width of central foot as  $5.400 \pm 0.62\text{cm}$ ; width of rear foot has  $4.205 \pm 0.52$ ; and planter arch index was recorded as  $1.285 \pm 0.01\text{cm}$ .

**Table 3: Descriptive Result of Male and Female Civil Servants with Flat Foot**

Variables	Right Feet						Left Feet					
	Male			Female			Male			Female		
	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min
CF	$6.303 \pm 0.37$	6.570	5.880	$5.400 \pm 0.62$	5.840	4.960	$6.740 \pm 0.724$	7.540	6.130	-	-	-
RF	$4.690 \pm 0.59$	5.240	4.060	$4.205 \pm 0.52$	4.570	3.840	$5.220 \pm 0.223$	5.420	4.980	-	-	-
PAI	$1.360 \pm 0.23$	1.620	1.220	$1.285 \pm 0.01$	1.290	1.280	$1.290 \pm 0.122$	1.430	1.210	-	-	-

Table 4 shows the descriptive result of male and female farmers with right and left flat foot. From the table, the results male farmers was; width of central foot  $5.717 \pm 0.54\text{cm}$ ; width of rear foot was  $4.683 \pm 0.52$ ; and planter arch index recorded  $1.285 \pm 0.01\text{cm}$ . Female was as follows; the right flat foot has the result of width of central foot as  $5.725 \pm 0.12\text{cm}$ ,

width of rear foot as  $5.010 \pm 0.71$ cm, and planter arch index was  $1.165 \pm 0.21$  cm. For left flat foot, the width of central foot revealed as  $4.525 \pm 1.83$ cm, width of rear foot showed  $3.545 \pm 1.78$ cm as the result, and planter arch index=  $1.310 \pm 0.14$ cm. The range of the width of central foot recorded 3.230-5.820cm, range of rear foot, 2.290-4.800cm, and that of the planter arch index=1.210-1.410cm.

**Table 4: Descriptive Result of Male and female Farmers with Flat Foot**

Variables	Right Feet						Left Feet					
	Male			Female			Male			Female		
	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min	Mean $\pm$ SD	Max	Min
CF	$5.717 \pm 0.54$	6.170	5.120	$5.725 \pm 0.12$	5.810	5.640	-	-	-	$4.525 \pm 1.83$	5.820	3.230
RF	$4.683 \pm 0.52$	5.030	4.090	$5.010 \pm 0.71$	5.510	4.510	-	-	-	$3.545 \pm 1.78$	4.800	2.290
PAI	$1.223 \pm 0.03$	1.250	1.190	$1.165 \pm 0.21$	1.310	1.020	-	-	-	$1.310 \pm 0.14$	1.410	1.210

Table 5 showed the prevalence of right and left normal and flat foot in relation to occupations. It showed that male civil servants has right normal foot as 53(94.34%), right flat foot 3(5.66%), left normal foot 53(94.34%) and left flat foot 3(5.66%). Female civil servant recorded right normal foot 43(93.03%), right flat foot as 2(2.97%). The left normal foot of female civil servant was 45(100%) while left flat foot has 0(0.00%). In male farmers, right normal and flat foot results were 66(95.59%) and 3(4.41%) respectively. This is also seen in left normal and flat male farmers as 68(100%) and 0(0.00%) respectively. Female farmers has 70(97.22%) and 2(2.78) both in right and left normal and flat foot respectively.

**Table 5: Prevalence of Normal and Flat Feet**

Subjects	Normal Feet%		Flat Foot %	
	Right	Left	Right	Left
Male civil servants	53 (94.34)	53 (94.34)	3 (5.66)	3 (5.66)
Female civil servant	43 (93.03)	45 (100)	2 (6.97)	0 (0.00)
Male farmers	66 (95.59)	68 (100)	3 (4.41)	0 (0.00)
Female farmers	70 (97.22)	70 (97.22)	2 (2.78)	2 (2.78)

Table 6 revealed the result of paired t test with right and left female farmers revealing significant difference while male civil servant, female civil servant and male farmers revealed no significant difference at  $p < 0.05$ . In table 7, paired t test of right and left normal feet of civil servants and farmers results were presented. The results, revealed no significant difference in right normal feet of both male civil servants and farmers, left normal feet of both male civil servants and farmers and left normal feet of both female civil servants and farmers while there exist significant difference in right normal feet of both male civil servants and farmers at significant level of  $P < 0.05$ .

**Table 6: Paired T-test of Right and Left Normal Planter Arch Index**

Parameters	$t_{cal}$	$P_{value}$	Remarks
Male Civil Servants	0.2983	0.7667	Not significant
Female Civil Servants	0.3209	0.7499	Not significant
Male Farmers	0.3375	0.7368	Not significant
Female Farmers	2.580	0.0120	Significant

At Significant Level of  $P < 0.05$

**Table 7: Paired T-test of Right and Left Normal Feet of Civil Servants and Farmers**

Parameters	t <sub>cal</sub>	P <sub>value</sub>	Remarks
Male Civil Servants and Farmers	0.3657	0.7161	Not significant
Male Civil Servants and Farmers	0.2762	0.7835	Not significant
Female Civil Servants and Farmers	3.268	0.0022	Significant
Female Civil Servants and Farmers	0.3983	0.6912	Not Significant

At Significant Level of  $P < 0.05$ 

Paired t test result in table 8 revealed no significant difference both in right and left flat foot of male civil servants and female farmers, also there is no significant difference in right flat feet of male civil servants and farmers at significant level of  $P < 0.05$ .

**Table 8: Paired T-test of Right and Left Flat Feet**

Parameters	t <sub>cal</sub>	P <sub>value</sub>	Remarks
Male Civil Servants)	0.3899	0.7342	Not significant
Female Farmers	0.5918	0.6598	Not significant

At Significant Level of  $P < 0.05$ **Table 9: Paired T-test of Right Male Civil Servants and Farmers Flat Feet**

Parameters	t <sub>cal</sub>	P <sub>value</sub>	Remarks
Civil Servants and Farmers	1.069	0.3970	Not Significant

At Significant Level of  $P < 0.05$ **Table 10: Chi-square Test**

Parameters	Chi-square ( $X^2$ )	P <sub>value</sub>	Remarks
Male Civil Servants and Farmers (Right Foot)	0.1374	0.9336	Not significant
Female Civil Servants and Farmers (Left Foot)	0.6095	0.7373	Not significant

## DISCUSSIONS

The medial longitudinal arch and the bony configurations of the foot indeed constitute the floppy shape of the foot, which play a role in shock absorption, support, and transmission of body weight in stance and dynamic positions. Absence of the medial longitudinal arch leads to flat foot, and could be due to a variety of factors which may be physiological or pathological (Krupa *et al.*, 2015).

The present study assessed the planter arch indexes and prevalence of flat foot in relation to occupation (farmers and civil servants) in Ikwo L. G. A of Ebonyi State, Nigeria. The mean values of normal Planter Arch Indexes (PAI) recorded among the male civil servants were  $0.85 \pm 0.11$  and  $0.80 \pm 0.10$  for the right and left feet respectively while the female civil servants was  $0.84 \pm 0.90$  and  $0.85 \pm 0.10$  for the right and left feet respectively. On the farmers, the male right and left mean PAI were  $0.84 \pm 0.90$  and  $0.84 \pm 0.08$  respectively; while on the female farmers, the mean PAI was  $0.80 \pm 0.14$  on the right and  $0.84 \pm 0.11$  on the left. These values are similar to those reported by Krupa *et al.* (2015), who reported the range of normal planter arch index as 0.72 to 0.73. This is also in line with the report of Pranati *et al.* (2017) who recorded the average normal PAI value of right foot among teens of age 14 to 17 years as 0.711 and that of the left foot as 0.74.

The mean of the right and left flat foot occurring among the male civil servants were  $1.36 \pm 0.23$  and  $1.29 \pm 0.12$  respectively whereas in females, it was  $1.29 \pm 0.01$  on the right, with all the measured left feet appearing normal. On the farmers, the mean of the right flat foot was  $1.22 \pm 0.03$ , with none occurring in the left. On the females the average of the right and left feet measured  $1.17 \pm 0.21$  and  $1.31 \pm 0.14$  respectively, with the differences not appearing statistically significant. There was no bilateral flat foot recorded and the occurrence of unilateral flat could be due to the type of footwear used especially during the period of development of the medial longitudinal arch.

The prevalence of flat foot in the present study was on 6.22%. This agrees with the result of Senadheera *et al.* (2016) where the prevalence among 722 participants in Sri Lanka was 5.95%. In buttressing this point, Abdel-Fattah *et al.* (2006) reported that the prevalence of flat foot among adult Saudi Arabian Army recruits of ages 18-21 years was 5.0%, although their value was lower, but still in the range of our result. However, it disagrees with the findings reported by Staheliet *al.* (1987) whose study was done on subjects of ages between 1 to 80 years with the percentage prevalence of 20%. Salvador *et al.* (2017) have it that 26.62% prevalence was recorded in their study with individuals between 40 years and above. A prevalence of 26.5% was reported in a study carried out by Otsuka *et al.*, (2003) on a population sample of 242 women and 98 men in Japan. The differences in these values could be due to the ages used in the studies.

In this study, the overall prevalence of flat foot in the male's was (3.7%) and (2.5%) in the female's which shows that prevalence of flat foot is higher in the males than in the females. However, this difference was not significant enough. This agrees with the reports of some findings such as Yashika *et al.* (2016) who recorded 21.8% prevalence among males and 17.9% in females in the age group of 18-24 years. Many other studies in the body of literature reported a higher prevalence of flat foot in males than in females such as the studies conducted by Pfeiffer *et al.* (2006); Murley *et al.* (2009); Chen *et al.* (2011); and Chang *et al.* (2010). This higher incidence of flat foot among males may be due to the use of wrongly designed footwear, inadequate exercise or overweight.

The prevalence of right flat foot was 4.15% while that of the left foot was 2.5%. Thus, our study recorded a higher prevalence of flat foot on the right than the left. This is in the same direction with the study of Senadheera *et al.* (2016) where the right and left unilateral flat feet were respectively 7.76% and 2.35% prevalent.

In relation to the occupations chosen in this study, the prevalence of flat foot among farmers was 2.90% and that among civil servants was 3.3%. This difference, however, was not statistically significant which implies that occupation does not affect the planter arch index of an adult. This point was further supported with the work done by Sachithanadam and Joseph (1995) whose findings suggested that the length of time (prolonged weight bearing) spent depending on occupation type is unlikely to cause flat foot. This as well explains the low prevalence of flat foot in adults after skeletal maturity, with most of them occurring as acquired flat (Yashika *et al.*, 2016) foot due to injury (such as joint laxity or peroneal tendonitis) directed to the particular foot bearing it.

## CONCLUSIONS

The present study empirically assessed the planter arch indexes and prevalence of flat foot among adults between the ages 18 and above, in relation to occupation in Ikwo LGA of Ebonyi State, Nigeria. The study was carried out on a population of 241 farmers and civil servants as the prevalent occupation in the area of the present study.

The normal planter arch indexes recorded in this study showed variations according to the variables chosen (occupation, gender, side of foot). However, these differences were not significant enough. The prevalence of flat foot was



higher among civil servants than in farmers, and the prevalence of flat foot was higher in the male than in female. A higher prevalence was also recorded in the right feet compared to the left. However, the variations among the variables did not make up a significant statistical difference at 0.05 significant levels. This therefore implies that occupation does not affect the planter arch index of a matured adult.

## CONFLICT OF INTEREST

There was no conflict of interest

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